

Successful Enhanced Bioremediation Using ORC Advanced® Follows Ex-Situ Groundwater Extraction Treatment

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SITE BACKGROUND

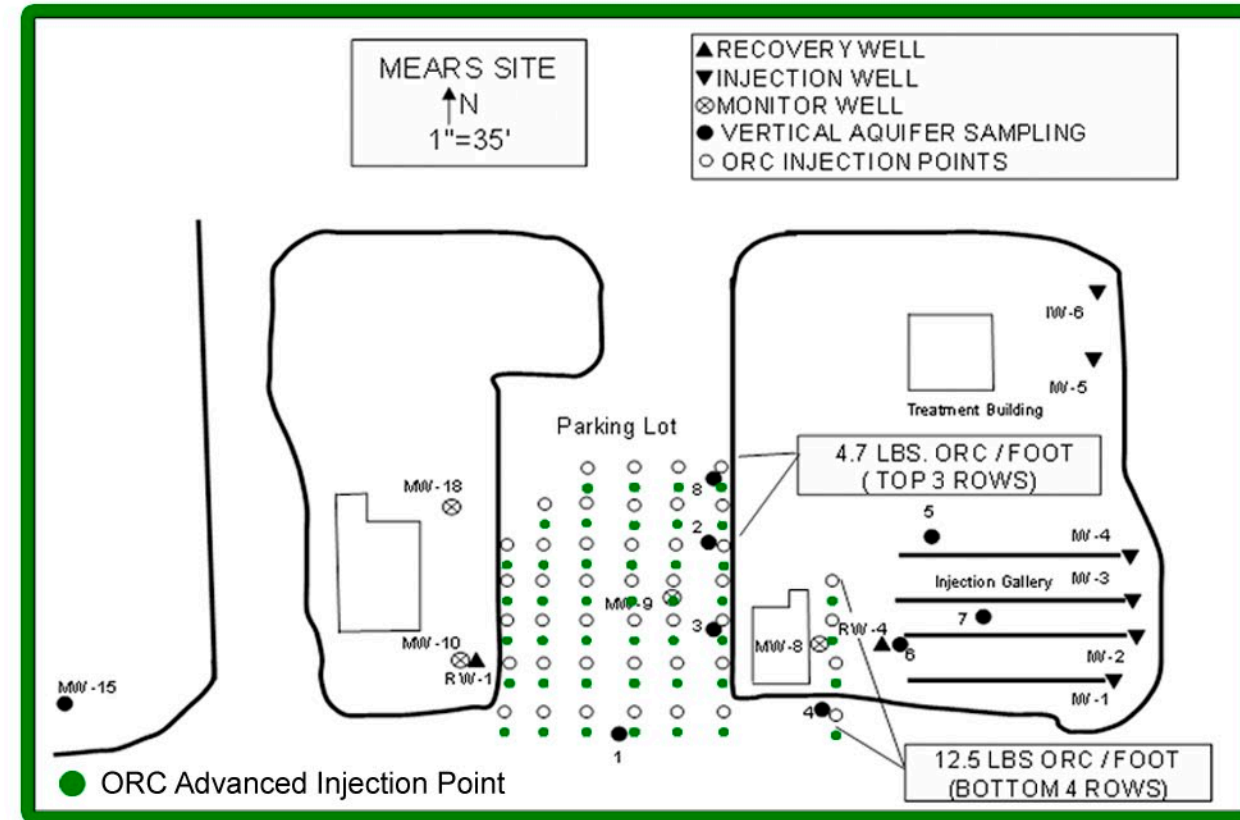


Figure 1. ORC Advanced® Injection Layout Around Well MW-9

Treatment Area: 4200 ft²
Soil Type: Sand
Depth to Groundwater: 25 feet
Technology Applied: ORC Advanced®

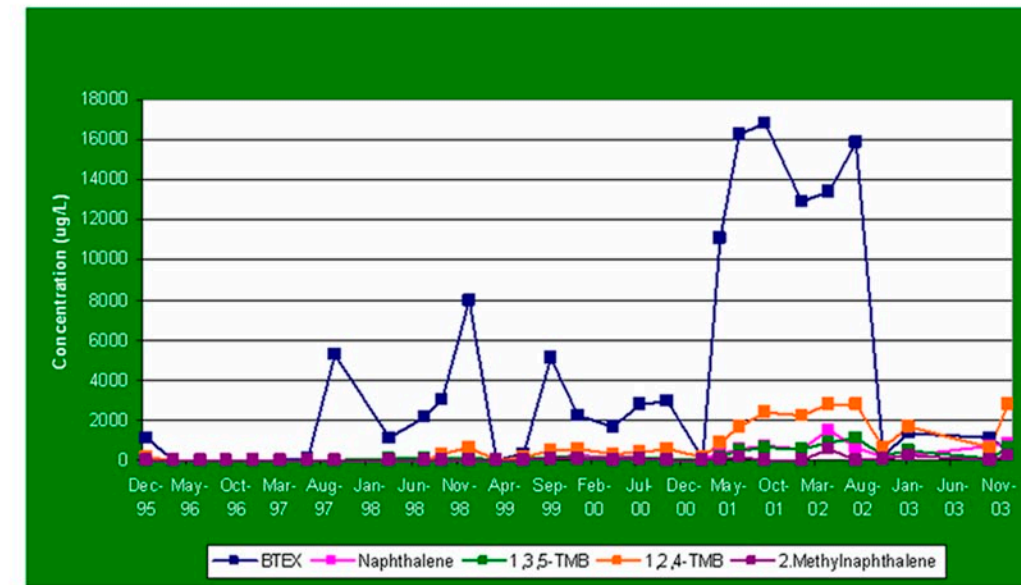
Quantity Applied: 2,325 lbs
Application Rate: 5 lbs/ft
Injection Spacing: 10 ft
Injection Points: 43

Two leaking underground storage tanks (USTs) resulted in soil and groundwater contamination at a service station in Michigan. Naphthalene, trimethylbenzene (TMB), benzene, toluene, ethylbenzene and xylene (BTEX) contamination were discovered in the subsurface prompting the need for remedial cleanup. The Michigan DEQ began remediation via UST removal and soil excavation. A total of 4,000 cubic yards of contaminated soil was removed. Post-excavation, groundwater contamination persisted and a pump and treat (P&T) system was installed and operated for 8 years through December 2003. Over time, the P&T system removed approximately 1,575 pounds of BTEX, however it was unable to effectively reach the lower contaminant concentrations required for site closure.

Contaminant	Concentrations	Cleanup Goals
Benzene	<1	5
Toluene	29	790
Ethylbenzene	110	74
Xylenes	322	280
Naphthalene	760	520
1,3,5-TMB	650	72
1,2,4-TMB	2800	63
2-Methylnaphthalene	220	260

TREATMENT APPROACH

Pump & Treat Performance



Graph 1. P&T Reduction of Petroleum Hydrocarbons over an 8 Year Period

Over the lifetime of the P&T system, significant increases and decreases in petroleum hydrocarbon contamination was observed. A lack of rainfall during certain parts of the remedial period contributed to some of the increases. During dry periods, the lack of infiltration from surface run-off water causes contaminant immobilization and can result in increases in concentrations within the capillary fringe smear zone. To address the problem, MDEQ installed an infiltration gallery in August 2000 to flush the contamination out of the unsaturated smear zone and into the dissolved-phase. Once the contaminants were mobilized and flushed into the dissolved-phase they were available for P&T removal. This process was clearly effective.

Prior to the P&T shutdown in November 2003, O&M costs were increasing and low-level, dissolved-phase concentrations were still elevated indicating the system was not effective at reaching the required low cleanup levels. Regulators began looking into ways of completing the remediation process and reducing the remaining cost of cleanup. Enhanced aerobic bioremediation using ORC Advanced® was chosen to replace the P&T system and degrade the remaining, low-level contamination. Three months after the P&T system was shutdown ORC Advanced® was applied on-site.

In-Situ Enhanced Aerobic Bioremediation

Regulators began looking into new ways of accelerating the remediation process and reducing the overall cost of cleanup. Enhanced aerobic bioremediation using ORC Advanced® was deployed to replace the P&T system and degrade the remaining contamination. Three months after the P&T system was shutdown ORC Advanced® injections took place.

ORC Advanced® is a controlled-release, oxyhydroxide-based peroxygen product designed to deliver pure oxygen to the subsurface. In this environment, microbes can effectively stimulate the aerobic degradation of petroleum hydrocarbons. ORC Advanced® delivers 17% oxygen by weight and can last up to 12 months on a single application.

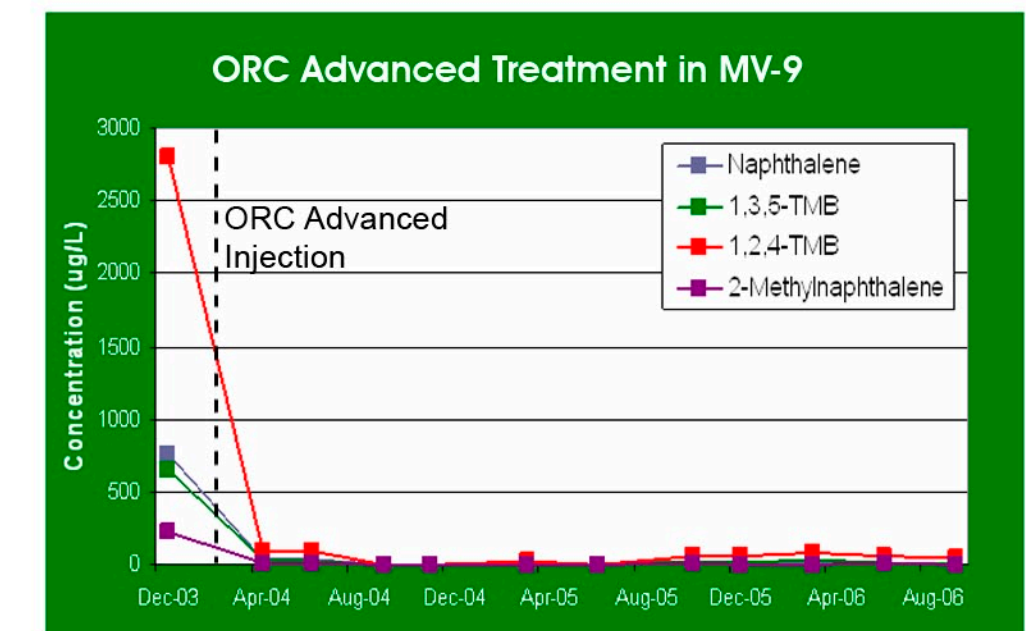
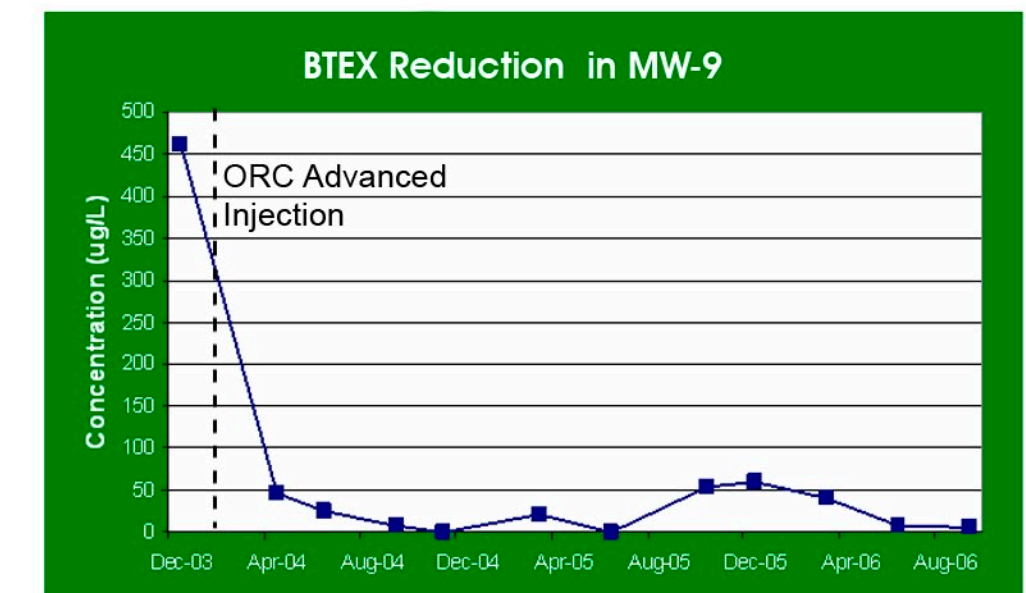


Figure 2. ORC Advanced®

RESULTS

ORC Advanced® Performance

Contaminant	Post-P&T/Pre-ORC Advanced® Levels	Post-ORC Advanced®	Percent Reduction
BTEX	461	6.4	98%
Naphthalene	760	<5	99%
1,3,5-TMB	650	6.4	99%
1,2,4-TMB	2800	47	98%
2-Methylnaphthalene	220	<5	99%



Conclusion

Within 60 days, low-level concentrations were significantly reduced below post-P&T levels (Table 2). Reduction continued throughout the monitoring period and a 99% mass reduction was achieved approximately 13 months after the initial injection.

The ORC Advanced® application eliminated the increasing O&M costs of an aging P&T system and accelerated site closure years ahead of schedule.